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AUTHOR Danowski, James
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ABSTRACT

An infographic model is proposed to account for the operation of systems within their information environments. Infographics is a communication paradigm used to indicate the clustering of information processing variables in communication systems. Four propositions concerning environmental uncertainty and internal communication network complexity, derived from the more extensive model, are tested at the group level of analysis in three different settings: a U.S. bank, two Korean villages, and a U.S. retirement community. Results show strong support across all three systems for the predicted positive relationship between openness and connectivity, and the predicted negative relationship between size and connectivity. The proposed relationships between zone size and connectivity and zone integration and connectivity receive mixed support. (Author)

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ENVIRONMENTAL UNCERTAINTY AND COMMUNICATION NETWORK COMPLEXITY: A Cross-System, Cross-Cultural Test**

James Danowski*
University of Southern California

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* Assistant Professor, Annenberg School of Communications and Research Associate, Andrus Gerontology Center.

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ABSTRACT

An infographic model is proposed to account for the operation of systems within their information environments. Four propositions concerning environmental uncertainty and internal communication network complexity, derived from the more extensive model, are tested at the group level of analysis in three different settings: a U.S. Bank, two Korean Villages, and a U.S. Retirement Community. Results show strong support across all three systems for the predicted positive relationship between openness and connectivity, and the predicted negative relationship between size and connectivity. The proposed relationships between zone size and connectivity and zone integration and connectivity receive mixed support.

INFOGRAPHICS

It is interesting to note the historical development of the major paradigms which have been used to segment and partition communication systems into smaller, more homogenous subsets. Traditionally, demographic analysis of such basic locator variables as sex, age, race, income, and education have sufficed.

However, because of growing equality in the distributions of basic locator variables within cultural subgroups having particular value and action profiles, psychographics has more recently emerged. Psychographics seeks to measure "life styles" and psychological profiles of people (Wells, 1974). Now, it is increasingly the case that within psychographic segments, as they typically broadly defined, there is considerable variety in personal information processing and a corresponding more basic world view. As such, there is an evolving movement toward the direct use of information processing variables for clustering participants in communication systems, even in such pragmatic areas as marketing. The author has labelled this third generation communication paradigm infographics (Danowski, in press).

Infographics is the study of how systems, ranging from individuals to large global networks, operate within their information environments. It identifies the structure of information environments, information needs, information seeking and information gathering activities of the system, and its information decoding, representation, transduction, transformation, storage, retrieval, encoding, and outputting back to the environment. Some key features of this paradigm are that infographics:

1. Is systematic, dynamically functional, and developmental
2. Seeks a logic generalizable across system levels

3. Uses network and communication entropy measures as the representational code for communication structures

4. Pursues rules of structural correspondence among information network regions.

INFOGRAPHIC HUMANISM

Infographic humanism is a philosophical grid which integrates naturally with the third generation paradigm. Most often in the past, Western culture has placed the locus of emphasis on technologies or the products of technologies. This tends to separate the human creators and consumers from their own information, and reifies it as objective, apart, and hence, alienated from the person. Infographic humanism, in contrast, recognizes that people are elemental units of information systems. Information systems grow out of human consciousness, anchored in it through both the creation and the consumption of messages. Thus, the focal point becomes human values, attributions of cause and control in the environment, and resulting personal information needs and functions.

Environment is viewed as an enactment (Weick, 1969) growing out of human consciousness. This enactment is shared to varying degrees with others through communication networks. The boundary separating personal space from environment is the zone of balance in the person's perceived control over components of the environment. The boundary is the midpoint on the dimension of control, distinguishing the region in which the person has less than 50% control over components of the environment. The remainder is that perceived under the control of "external" factors.

In more specific terms, infographic humanism is generally consistent with a number of emerging areas of communication theory and research: the "uses and gratifications" approach to mass communication (Katz, et al., 1974),

information needs, information seeking, and decision analysis. However, an area currently highly underdeveloped is research on human values and the relationships of value structures to communication structures.

INFOGRAPHICS AND SOCIAL POLICY

The basic humanistic assumptions of infographics result in important social policy considerations. A few of the highlights are as follows. The centrality of human consciousness, values, and balance principles in infographics implies in the policy realm a "true democratic" political process, with policy emanating colletively and directly from the people, and with the people primarily benefiting in its effects.

At a much more pragmatic level, infographics suggests particular social welfare and social service philosophies. One timely example is the movement toward functional theories of social service provision. Currently, the federal government is considering the implications of a shift toward the use of functional criteria in social services allocation rather than simply demographic criteria (Walther, 1975). For example, rather than have mandatory retirement at a certain chronological age, it would be based on personal ability to meet certain standards of functioning. Elsewhere, the author has explicated a theory of informational aging (Danowski, 1975a; in press) which is a functional infographic theory of individual maturation and communication activity, and which suggests the importance of communication structure in social service assessment, delivery, and organization.

RECOGNIZING ORGANIZATIONS IN GLOBAL INFORMATION NETWORKS

Principles of infographic humanism, while anchored at the individual level, do not limit the levels of analysis at which infographic theory

and research is pitched. The present paper is in fact focused on more macro levels. However, conistent with the larger perspective, groups and organizations are viewed as primarily rooted in human consciousness and comprised of individuals as fundamental elements.

In a sense it can be assumed for illustrative purposes that all possible organizations already exist in some form within global information networks. Thus, organizations are simply the repatterning, recombination or "recycling", as it were, of existing information networks. At the outset this assumption may appear rather weak, since it is well known that personal communication behaviors change rather frequently throughout the life spans of individuals. However, at a more abstract level, human communication behavior is rather stable. There appears to be relative constancy in the number of links, irrespective of whom they are with, an individual actively uses and also, in the variance in network interconnection and integration.

However, a counter factor is the global population growth rate, which expands the information base which potentially can be patterned into organizations. Nevertheless, in the short run, there are definite boundaries on the global information network out of which organizations can be formed. How can organizations be recognized in the staggering extensiveness of global information networks? The following criteria are simple, yet comprehensive. First, there must be a mediation of information within the system, such that the same message is processed by more than two persons, and this mediation must recur over time. Second, there must be a public naming or labelling of the information mediation process, such that all members within the system recognize the organization by this name or concept. The boundary region separating the organization from its environment is the space defined through environmental components over

which the organization recognizes itself to have greater than midpoint, or 50%, control.

AN INFOGRAPHIC MODEL OF ORGANIZATIONS

ENVIRONMENTAL UNCERTAINTY

Environmental uncertainty,[1] variously defined in the literature (Emery and Trist, 1965; Thompson, 1967; Lawrence and Lorsch, 1967; Terryberry, 1968; Duncan, 1972; Tosi, Alday, and Storey, 1972) is viewed here as located within the cognitive processes of persons communicating within social systems. At the organizational level, it is located within the shared conceptual domains of the participants, and thus a necessary condition is the functioning of a communication network occurring through various media or face-to-face channels. The beginning basis for environmental uncertainty is the conceptualization of distinct units within a relevant portion of the environment. This requires discrimination. Next, units must be positioned with respect to one another, which is differentiation. Subsequently, there must be some level of integration[2] of these elements into a wholistic pattern or "image".

The particular structural nature of these integrating patterns may vary widely across various sectors of the environment. However, no matter what particular pattern is acceptable to the system qualitatively, a universal quantifiable dimension is the degree of pattern completeness. Completeness is attained when appropriate stress-minimizing linkages among concepts are formed. The extent to which completeness is not acheived is the amount of uncertainty conceptualized within that subset of the environment.

UNCERTAINTY EXPANSION AND REDUCTION

The process of forming linkages among already discriminated and differentiated elements, increasing completeness, is an uncertainty reduction process. Correspondingly, uncertainty expansion is the prior process of discriminating and differentiating elements, as well as weakening existing linkages among them. Now, what is information? In the mathematical model, information is only uncertainty reduction. Uncertainty expansion is undefined except as "noise" (Shannon and Weaver, 1949). However, for the author it is not satisfactory to view the expansion of human awareness of environmental elements simply as noise, because of the negative popular conception of this term. Also, because the common use of the term "information" applies to both expansion and reduction, then clearly it is not desirable to use it only in the narrow mathematical sense. The author prefers to label all exchange of pattern with an environment as an information process (Berlo, 1970), and simply apply when necessary the appropriate adjective of "uncertainty reducing" or "uncertainty expanding" to the noun "information".

THREE LEVELS OF COMMUNICATION STRUCTURE

Aside from "imaging" information, which is largely semantic, there is syntactic or structural information which a system processes. In general, structural variables appear to account for more than 50% of human behavior. Imaging, particualrly of the sort involving awareness of related patterns of behaviors and causal attributions seems to be only the "tip of the iceberg". Clearly, many biological organisms do not appear to us to have imaging capability, yet it can be easily observed that the structure or variety of their environments makes a major difference in their behavior patterns, and in many ways similar to humans.

The structure or patterns of the external environment may be viewed at three primary levels: channel entropy, content entropy, and form entropy (Danowski, 1975a). Entropy varies positively as a function of the number of alternatives in the set, and the equality of the distribution of their probabilities of occurrence. Channels are the "carriers" of information linking the system with the environment and may be various kinds of mediated or face-to-face links, and varying in the degree to which the "same" message is processed by more than one person. Content is the semantic aspects of pattern exchanged through channels. Form is the manner in which messages are organized and packaged. Thus, these three levels may be viewed as imbedded subsets: form within content, content within channels.

These three levels of structure are associated with the following environmental information variables. First, greater openness (Katzman, 1970) -- the volume of information exchange with the environment -- increases content and form entropy and thus leads to greater environmental uncertainty. Second, zone size (Barnes, 1972) -- the number of alternative systems to which a particular system is linked -- in part determines channel entropy, and hence environmental uncertainty. Third, content entropy is negatively associated with zone integration, which is the extent that systems which are linked to a particular system are linked to one another. As a zone becomes more integrated, the homogeneity of information content increases.

An additional contributor to environmental uncertainty is resource competition, or the density of organizations per resource base (Coleman, 1957; Stinchcombe, 1965). From an economic perspective, the resource base of systems is limited in supply. As demand for these resources increases, competition for limited resources will lead to greater uncertainty about

the availability and stability of resource inputs for processing. On the output end, greater density may also lead to an over supply of outputs. The competition for the distribution and exchange of these outputs will lead to conditions of uncertainty for participant systems.

INTRASYSTEM COMMUNICATION NETWORK COMPLEXITY

Internal information processing capacity of a system is a function of the complexity of the communication network. A communication network represents an information processing system as a set of people (or elements comprised of sets of people) who are linked together through information exchange. It is sometimes useful to conceptualize people as "balls" in space, with rubber bands linking them together if they communicate, and the bands thickening with the amount of information exchange taking place (Danowski, 1973). At a group level of analysis the complexity of the internal communication network can be defined simply as a function of the extent to which people within the group are linked with one another, known variously as "communication integration" (Rogers, 1971), "density" (Granovetter, 1974), "connectedness" (Monge, 1971) and "connectivity" (Danowski, 1974). This latter label is used here. As more alternative connections exist among people, it becomes increasingly uncertain as to the particular path a message will take upon entering the system boundaries. Thus, at an abstract level, the predictability of message paths is a key component of communication network complexity.

At the organizational level, a basic unit of analysis within communication networks is communication groups, comprised of more than three individuals who exchange more than 50% of their communication with one another, and all being directly or indirectly linked. Greater complexity of an organizational communication network is defined more specifically as follows:

(1) greater balance between initiation and reception of messages by nodes in the network,

(2) greater numbers of groups in the network (differentiation),

(3) higher degree of connectivity within groups,

(4) lower interconnection among groups (integration),

(5) greater number of bridges relative to the total number of links between groups,

(6) fewer numbers of status levels contained within the network relative to the number of nodes,

(7) more rapidly changing network structure.

TECHNOLOGY: AN INFORMATION ACTION LOGIC

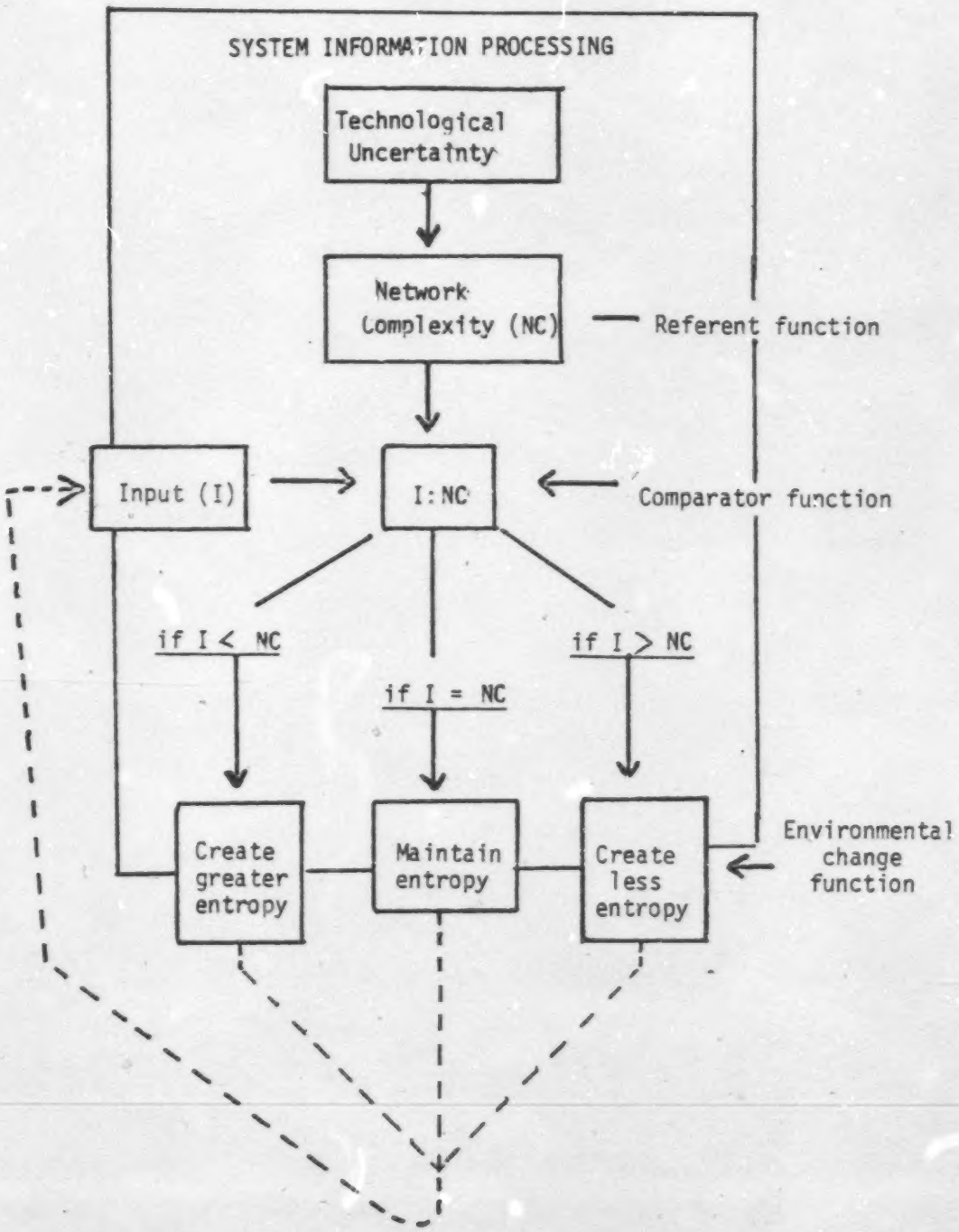
Information processing in systems is typically governed by a "policy" or action logic. Technology, variously defined in the literature,[3] is simply defined here as an information and/or materials processing logic for action. Clearly, in many systems action logics heavily depend on particular configurations of "hardware", normally alone thought to be technology. However, hardware is merely the result of the imposition of a great deal of structure on the action logic, to the extent that physical materials are transformed and fixed to incorporate the logic.

The extent to which technologies are fixed in material configurations varies widely across systems. Nevertheless, no matter what the particular level of materialization, a universal dimension is the extent to which certainty of input, transformation, and output is required. Thus, technologies drive the information processing of a system, providing a logic for actions. The practice of the technology results in information exchange among people, and therefore a system's communication network is a representation of the communication "by-products" of a technology.

Figure 1 About Here

Figure 1

BASIC COMPONENTS OF THE MODEL



THE FUNCTIONS OF COMMUNICATION

The basic logic of the infographic model is illustrated in Figure 1. Essentially, a system is viewed cybernetically. The system has a range of information processing capacity which is a function of the level of complexity of its internal information processing structures.[4] In the short run, as the complexity of the information environment falls above or below the acceptable range, the system will alter the environment to bring it into line with capacity. Thus, if the system is underloaded, it will create more complexity in its environment. On the other hand, if the system is overloaded (Miller, 1964), it will create less complexity. This suggests two major functions of communication: uncertainty expansion and uncertainty reduction.

Organizational planning may be viewed primarily as an example of uncertainty reduction. Obviously the start-up phases of planning involve the expansion of alternative conceptions of the environment. However, overall, most planning energies are directed toward forming a clear set of linkages among concepts which entail specific organizational actions. The completeness of these patterns reduces the uncertainty of the environment. Prior research (Goodman, 1973) has shown that organizations most uncertain about their present environments plan further years ahead into the future.

CORRESPONDENCE OF COMMUNICATION STRUCTURES

The implication of the above logic is that over time, the complexity of the structure of the information environment will be positively associated with the complexity of intrasystem communication networks,[5] because the deviations of environmental complexity and the actions taken to correct them will average out to correspond to internal network complexity.

Because, as was discussed earlier, technology is the driving force behind the operation of communication networks, the need for technological certainty will determine a corresponding intrasystem network complexity and environmental complexity. The greater the need for technological certainty over time, the less complex the environment and the less complex the internal communication network.

THE STRUCTURAL ADAPTATION COEFFICIENT: LEARNING

While in the short term, a relatively fixed capacity for information processing has been assumed, over the long term the system will adapt in varying degrees to the structure processed previously. This formula represents the relationship:

$$NC_{t_n} = NC_{t_{n-1}} + aEC_{t_{n-1}}$$

It suggests that each interaction with the environment leaves its imprint on the complexity of internal communication networks (NC). The extent to which repeated deviations of environmental complexity (EC) from system capacity increment or decrement capacity, as the case may be, is a function of the magnitude of the adaptability coefficient (a). Thus, the capacity at $time_n$ is a function of capacity at $time_{n-1}$ plus the product of the adaptability coefficient and the complexity value of the environmental information at $time_{n-1}$.

Technologies set the magnitude of the adaptability coefficient. The wider the variance in certainty the techology requires, the larger the coefficient. Generally, however, technologies do not tolerate much variance in input, transduction, and output certainty, and as a result the rate of change in capacity for a particular technology is rather slow. Hence, overall, a system experiencing an increasing deviation of environmental uncertainty must gain greater <u>control</u> over larger and larger portions of

what was once the environment so that a proper complexity can be maintained. This process results in, among other things, larger system size (in terms of the number of human elements). Input and output "buffering" has been explicated as one mechanism used by organizations to control environmental uncertainty. The creation of buffers, by definition, increases the size of the organization (Thompson, 1967). The net result of these principles is that sucfessful systems with high needs for technological certainty, and thus having greater control, will be larger in size, have less complex internal communication networks, and a less complex environment. In addition, given this greater need for technological certainty, and thus control, these organizations will initiate change in areas outside the technology more rapidly.

SUMMARY OF PROPOSITIONS

The following summarize major assumptions and propositions of the infographic model, although others can also be extracted. Obviqusly a number of other propositions can be derived from those below.

1. Greater system openness produces greater entropy of environmental communication structures.
2. Greater zone size of a system produces greater entropy of environmental communication structures.
3. Greater zone integration of the system produces less entropy of environmental communication structures.
4. Greater density of systems per resource base produces greater entropy of environmental communication structures.
5. Greater system overload at a point in time produces less subsequent entropy of environmental communication structures.
6. Greater system underload at a point in time produces greater subsequent entropy of environmental communication structures
7. Two major functions of communication are uncertainty expansion and uncertainty reduction.

8. Greater present environmental uncertainty of a system produces planning further into the future.

9. Greater need for technological certainty of a system produces greater percieved control over environment.

10. Greater need for technological certainty produces less complex internal communication networks in the system.

11. Greater need for technological certainty produces less entropy of environmental communication structures (i.e., smaller zone size, less openness, and more highly integrated zones).

12. Greater need for technological certainty produces greater system size under conditions of uncertainty discrepancy.

13. Greater need for technological certainty produces less adaptation in the complexity of internal communication networks to discrepant environmental complexity.

A CROSS-SYSTEM, CROSS-CULTURAL TEST

A set of propositions derived from the infographic model are tested with three different sets of communication network data: a U.S. Bank, two Korean Villages, and a U.S. Retirement Community. Given only four distinct organizations, it is most appropriate to conduct the test at the group level of analysis. Because each of these data sets was gathered for another primary purpose, only a limited set of variables are available. All of them are defined through indexing of the structural characteristics of their respective communication networks.

Network analysis was performed on all three sets of data using the NEGOPY (short for negative entropy) computer program (Richards, Farace, and Danowski, 1973; Richards, 1974) operative at Michigan State University. The same network analysis criteria were used consistently across all

three systems; the only differences are that the communication frequency ranges vary.[6]

The set of testable derived propositions are the following:

1. The greater the openness, the greater the internal communication network complexity of the system.
2. The greater the zone size, the greater the internal communication network complexity of the system.
3. The greater the zone integration, the less the internal communication network complexity of the system.
4. The greater the system size, the less the internal communication network complexity.

Operational definitions of the variables are provided in table 1. System openness is the total of all frequencies of communication between the group and elements of the environment. Zone size is the total number of groups linked to a particular group. Zone integration is the extent to which linkages among groups, which are linked to a focal group, are equally distributed. Internal communication network complexity is the connectivity among members of the group. System size is the number of people in the group.

Table 1 About Here

Table 1

SUMMARY OF CONCEPTUAL AND OPERATIONAL DEFINITIONS OF VARIABLES

Variable	Conceptual Definition	Operational Definition
Group Size	Number of nodes in a group.	$GS = n$ Where n is the number of nodes in the group.
Openness	Extent to which a group has links with nodes in its environment, relative to group size.	$O = e/n$ Where e is the number of links with nodes in the environment, and n is the number of nodes in the group.
Zone Size	One-step: Number of groups directly linked to a focal group. Two-step: number of groups linked to groups directly linked to a focal group. Each relative to group size.	$ZS = s/n$ Where s is the number of systems linked with a focal system, and n is the number of nodes in the groups.
Zone Integration	Extent to which the groups to which a focal group is linked are linked to one another.	$ZI = \frac{-\sum p_i \log_2 p_i}{\log_2 N}$ Where pi is the number of groups to which a group is linked, minus 1 divided by the total number of groups linked across all groups and N is the number of groups.
Connectivity	Number of actual links in a group relative to the total number of possible links in a group.	$C = \frac{L}{n\,(n-1)/2}$ Where L is the number of actual links and n is the number of nodes in group.

Test One: A U.S. Bank

Data were gathered in one large division of an eastern U.S. bank. The task activity of the system involves the processing of transactions in stocks and bonds. The entire system was censused, yielding an "N" of 963. Communication content areas of production, maintenance and innovation were all combined for the analysis. All of the propositions in the previous section were able to be operationalized in the available data. The 37 groups with more than one link to another group in the environment were used in the analysis.[7] Descriptive statistics for all variables appear in Table 2.

Table 2 About Here

The distributions all appear to be relatively normal. Simple correlations among all the variables appear in Table 3. The correlations between connectivity, and openness and system size are substantial, with the size and connectivity correlation being extremely large. All of the independent variables were simultaneously entered into a least squares, linear multiple regression on the dependent variable -- the connectivity measure of network complexity. Regression information appears in Table 4. This set of independent variables yields a multiple correlation coefficient of .84, explaining 70% of the variation in communication network complexity. Much of the explained variance can be attributed to size alone.

The first proposition is given support by the data. The beta weight for openness in the regression is .25. This indicates that as the system becomes more open, the system has a more complex internal communication network structure. If openness is associated with higher environmental uncertainty, then this is further support for the general proposition that as environmental uncertainty increases, the complexity of the internal

Table 2

Descriptive Statistics

Variable	Minimum	Maximum	Mean	S.D.
Connectivity	0.13	0.83	0.43	0.16
Openness	21.00	534.00	156.70	39.20
Zone Size	0.00	7.00	2.73	1.17
Zone Integration	0.00	1.00	0.45	0.46
System Size	3.00	16.00	8.43	3.48

(N =37)

communication network structure of the system increases.

The second proposition (the greater the zone size, the greater the complexity of the internal communication network of the system) is not supported by this analysis. The beta weight for the zone size in the regression is .02.

Tables 3 and 4 About Here

A degree of support is found for proposition 3, with a beta weight for zone integration of -.30. This indicates that as the zone of a system becomes more integrated, its internal communication network complexity decreases. As with proposition 1, this indicates support for the more general proposition that as environmental uncertainty increases, the internal communication network complexity increases.

The fourth proposition is also supported by the data. The beta weight for system size is -.75. This indicates that as the size of the system increases, the internal communication network of the system becomes less complex.

Test Two: Korean Village Mothers

Data on the family planning communication patterns of women in two Korean villages (n = 39 for each village) were network analyzed (for a discussion of the Korean Village project see Kincaid and Yum, 1975; Rogers, et al., 1975).[8] The present research is at the group level of analysis, and thus, the concern is not with differences between the two villages taken as distinct entities, but with relationships among structural characteristics of the network groups taken together from both villages. Therefore, the analysis focuses on the five groups defined within the two villages. The analysis to follow regarding these groups is limited by the small size of the data set. With such a small number of

Table 3

Simple Correlations

	1	2	3	4	5
1. Connectivity	1.00				
2. Zone Size	.00	1.00			
3. Zone Integration	-.13	.07	1.00		
4. Openness	.39	.38	.15	1.00	
5. System Size	-.75	.12	-.17	-.22	1.00

Table 4

Multiple Regression Information

Dependent Variable: Connectivity

A. Analysis of Variance for Overall Regression

	Sum of Squares	d.f.	Mean Square	F	sig.
Regression (about mean)	.63	4	.16	18.5	.0005
Error	.27	32	.008		
Total (about mean)	.89	36			

B. Multiple Correlation Coefficients

R^2	R	R Bar^2	R Bar	Standard Error
.70	.84	.66	.81	.09

C. Independent Variables

Variable	Beta Weight	S.E.	sig.
Zone Size	.02	.11	.842
Zone Integration	-.30	.10	.005
Openness	.25	.11	.028
System Size	-.75	.10	.0005

nodes--39 in each village--the number of groups that could be maximally identified in the networks is very small. Table 5 shows the values of the variables for each group.

Table 5 About Here

Figures 2 and 3 About Here

The propositions tested here are those specified earlier regarding the predictors of connectivity within systems, with the exception of those dealing with zone size and zone integration. Since there are a limited number of groups, the calculation of these two measures does not yield meaningful results, and hence, these propositions cannot be tested.

1. The greater the openness of a system, the greater its connectivity.

Figure 2 graphically shows the association between these two variables. A best fit line has been estimated for the data points. Inspection shows evidence of a positive relationship between openness and connectivity as predicted, and as found in test one. Correlations were also computed. However, the very small n's make these far from reliable estimates, and so they are intended as merely suggestive and illustrative. The correlation between openness of groups and their connectivity is .34.

2. The larger the system size, the less the connectivity.

Figure 3 shows that as predicted, there is an inverse relationship between size and connectivity. The correlation between the two variables is -.79. These results, in light of those noted earlier with the more robust test one, suggest that size has a major association with system connectivity.

Test Three: A U.S. Retirement Community

Communication network data were gathered in a Midwestern retirement community, a complex of self-contained apartment units inhabited by white, working and middle class residents (n= 187). 82% of the sample are women,

Table 5

Summary of Variable Values by Group

Variable	Group A-1	A-2	A-3	A-4	A-5
Connectivity	0.35	1.00	0.50	1.00	0.15
Openness	1.18	0.33	0.40	1.60	0.27
System Size	11.00	3.00	5.00	5.00	30.00

Figure 2. Korean Villages: Openness and Connectivity

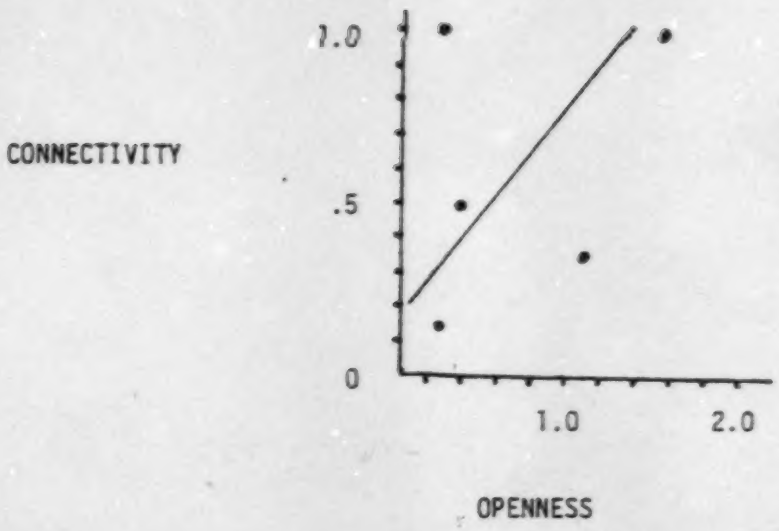
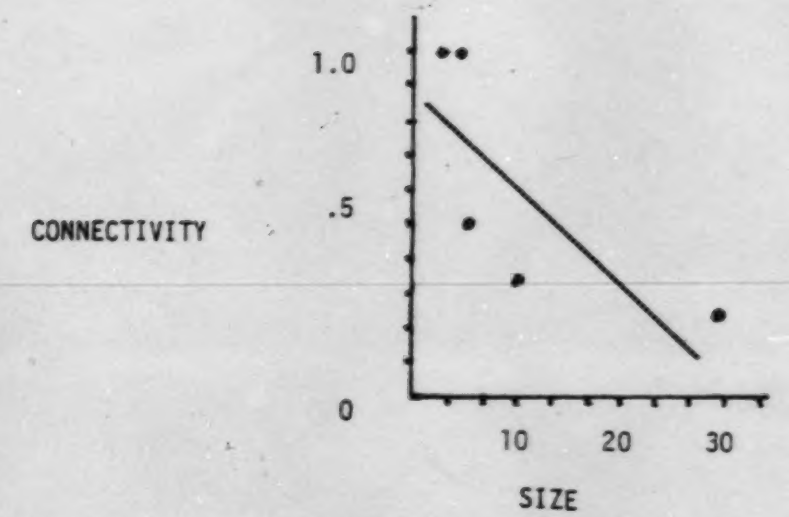


Figure 3. Korean Villages: Size and Connectivity



and the average age is 72. The larger project from which these data come is fully described elsewhere (Danowski, 1975). Eleven groups emerged from the network analysis. Descriptive statistics for the communication structure variables for retirement community groups appear in Table 6.

Table 6 About Here

Figures 4, 5, and 6 About Here

1. The greater the openness, the greater the internal communication network complexity of the system.

As with the Korean data, scatter plots with best fit lines for the predicted associations appear in Figures 4-7. Correlations are also reported here for illustrative purposes, although again the group sample size is very small. Figure 6 shows support for the proposition, having a positive correlation of .46. Thus, this proposition receives evidence of support across three widely different samples.

2. The greater the zone size, the greater the internal communication network complexity of the system.

Zone size shows the expected relationship with group connectivity, which was also found in the U.S. Bank data, but was not measurable in the Korean data. Thus, in both systems in which the proposition is testable, support is derived. The correlation of zone size with group connectivity is .62.

3. The greater the zone integration, the less the internal communication network complexity of the system.

Table 6

Descriptive Statistics

Variable	Minimum	Maximum	Mean	S.D.
Connectivity	0.06	1.00	0.54	0.26
Openness	5.40	22.62	8.48	5.00
Zone Size	1.00	10.00	3.63	2.14
System Size	3.00	76.00	13.54	21.06

Figure 4. Retirement Community: Openness and Connectivity.

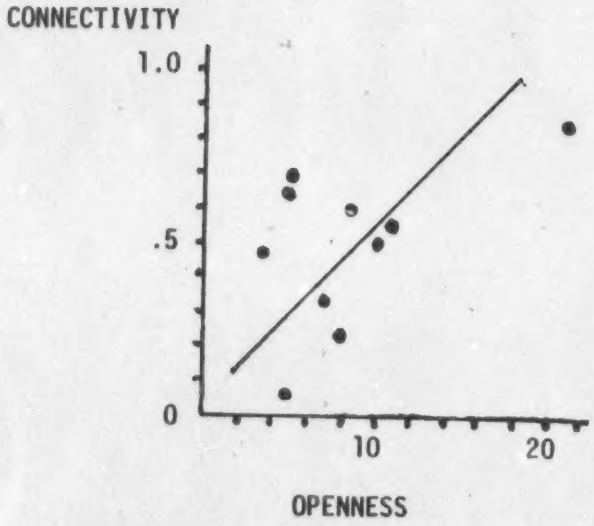


Figure 5. Retirement Community: Zone Size and Connectivity.

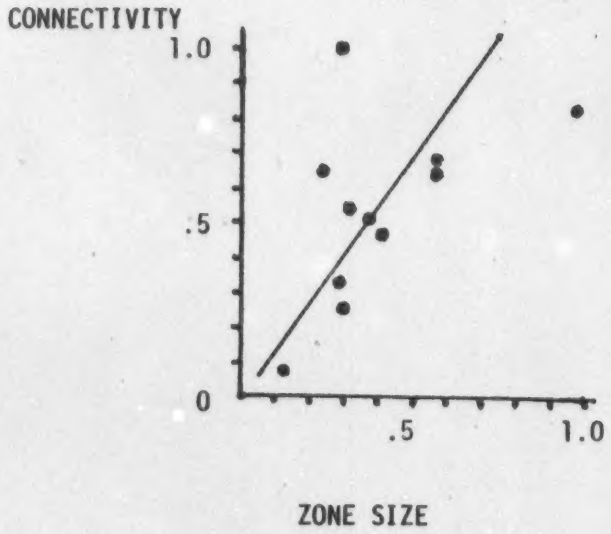


Figure 6. Retirement Community: Zone Integration and Connectivity.*

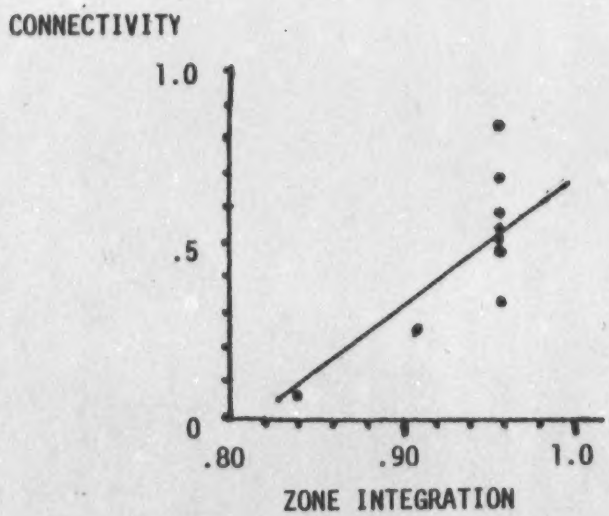
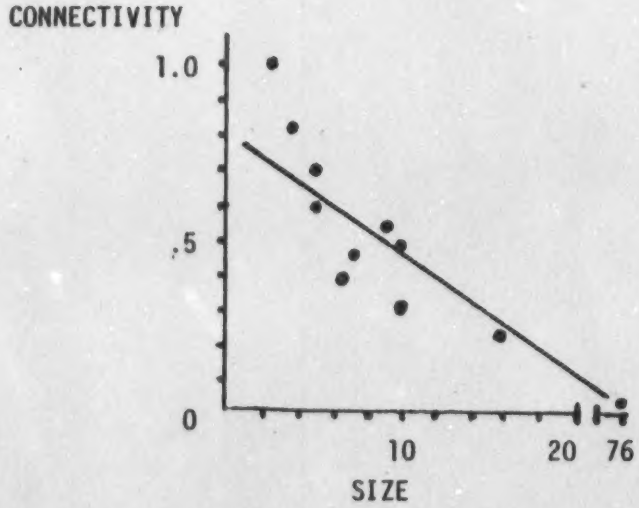


Figure 7. Retirement Community: Size and Connectivity.



* Two groups had no links to other groups and therefore, zone integration connot be computed.

Figure 7 does not show the expected relationship between zone integration and group connectivity. In fact, the direction of the association is positive and rather strong (r = .31). This is inconsistent with the results of the test in the Bank sample, which does show the predicted positive relationship. Recall that the test was not possible in the Korean data.

4. The greater the system size, the less the internal communication network complexity.

Figure 8 clearly shows the predicted negative association between system size and the complexity of its internal communication network structures. The correlation coefficient is -.72. Thus proposition 4 is supported by three sets of data gathered in different social systems. This proposition receives the strongest support of all those tested.

DISCUSSION

A summary of the results of the three system test of the four infographic propositions appears in Table 7. Clear support is shown from all three samples for the propositions concerning connectivity, and openness and system size. The other two propositions concerning connectivity and zone size and integration receive mixed support. In particular, the zone size proposition is not supported in the Bank, but is supported in the Retirement Community, while the zone integration is supported in the Retirement Community, but not the Bank. Neither are testable in the Korean Villages.

Regarding the strong support for the expected relationship between system size and connectivity, size has traditionally been found very

important as a predictor of many organizational characteristics. However, social scientists have often been perplexed by the pervasiveness of a variable as simple and seemingly mundane as size. The infographic model developed in this paper accounts for size's association with other organizational variables in a meaningful way. A system's requirements for technological certainty has been proposed as an important driving variable.

Regarding the strong support for the proposed relationship between openness and connectivity, the high stature of the concept of openness in General Systems theories finds empirical credibility in the present analysis. In all three systems, as their respective groups exhibited greater openness relative to their size, they showed a more complex internal communication network structure.

In attempting to offer explanations for the mixed support propositions, a most basic consideration is the validity of the zone size and integration measures in capturaing variance in environmental uncertainty. As it is currently computed, zone size is a very simple measure. The present measure accounts only for the number of alternative channels used, and not the relative patterns of activiation of these channels. Perhaps measures more sensitive to the relative distributions of communication frequencies within a given zone size are more useful. Likewise, perhaps zone integration is an imprecise surrogate measure for information content diversity. To derive environmental uncertainty from the zone integration measure, the inference must be made that the more interlinked components of the environment are, the more homogeneous the information content flowing through to the focal system. However, for analytic purposes it may be that overall, the relationship is not strong enough to consistently substitute for content diversity.

Table 7 About Here

Another plausible explanation derives from the relative nature of the larger environmental settings in which the Bank and the Retirement Community are embedded. Intuitively, the Bank appears to have a much more heterogenous environment than the Retirement Community. The latter has members who are highly homogenous in basic demographic characteristics. All residents are Caucasian, most are Protestant, of rural backgrounds, and mostly of working to lower middle-class socio-eocnomic status. In addition, the community as a whole has relatively little interaction with the larger environment, being largely isolated in terms of physical environment and transportation access. Also, in the level of organized activity, this particular community is very low relative to similar types of residential facilities. Overall, these characteristics suggest a homogeneous and simple general environment in which the system-wide communication network is embedded.

On the other hand, the Bank, without saying operates, in a more heterogeneous and complex larger environment. If it is assumed that the more simple measure of zone integration is more valid in a more simple environmental setting, then it is understandable that the simple measure will not be predictive in the complex Bank environmental setting, but will be predictive in the simple Retirement Community environment.

In addition to zone size, the zone integration measure may also be considered in light of the overall environmental contexts of the two systems. In the complex larger environment, the zone integration measure may adequately capture the information content diversity flowing through the focal system. However, in the simple larger environment, there may be very little information content diversity overall, and hence the zone

Table 7

Summary of the Results

Proposition	Bank	Villages	Retirement
1. The greater the system openness, the greater the complexity of internal communication networks.	yes	yes	yes
2. The greater the zone size, the greater the complexity of internal communication networks of the system.	no	--	yes
3. The greater the zone integration, the less the complexity of internal communication networks of the system.	yes	--	no
4. The greater the system size, the greater the complexity of internal communication networks.	yes	yes	yes

integration measure will be essentially uncorrelated with information content diversity in this type of setting.

A third explanation involves the technologies, or information action logics, operating in the Bank and Retirement Community. It may be the case that the indivuduals in the respective systems may have largely different needs for technological certainty. Thus, as the infographic model proposes, the collective systems will vary in their level of adaptability, in terms of the change in internal network complexity that is experienced after the processing a level of environmental entropy which is discrepant with original capacity. In short, systems with higher requirements for technological certainty will be less adaptive to a changing environmental entropy in terms of internal communication network complexity.

Indeed, a theory of Informational Aging (Danowski, in press) proposes that, given the contemporary U.S. culture, there will be a positive association between chronological age and the need for technological certainty, and that these functionally older individuals have preferences for a less entropic information environment. Thus, in the current Retirement Community sample, it would be consistent to find groups with a lack of correspondence between the entropy of the information environment and the complexity of internal communication network structure. The implication of the infographic model is that these less adaptive systems with higher needs for technological certainty (and thus less complex internal networks), will increase in size, given the processing of discrepant environmental information. In the present data, the two largest systems do in fact show the greatest imbalance between zone integration and connectivity. It would be interesting to see if this imbalance appears to be compensated for through mediated communication (Danowski, 1975). If this is the case,

these two groups would show a relatively ~~high~~ low degree of entropy in the structure of mass media use.

In conclusion, although strong and consistent support has been found for two of the infographic propositions within three sets of data, and mixed support found for two propositions within three sets of data, the present test can hardly confirm nor deny the infographic model. In one sense, the cross-system test within a U.S. Bank, two Korean Villages, and a U.S. Retirement Community is based only on a sample size of three. Nevertheless, the present analysis yields some interesting clues. More cross-system testing is an obvious future pursuit of merit.

NOTES

1. These three main factors--discrimination, differentiation, and integration--are the three major components of cognitive complexity discussed by Schroder, Driver, and Streufert (1967).

2. The work of Emery and Trist (1965), Thompson (1967), Terryberry (1968), and Duncan (1972) suggest two major dimensions to environmental uncertainty: simple-complex, and static-dynamic. This is an interesting analogy to the novelty and complexity dimensions of stimuli developed in psychology by Berlyne (1968). Garner (1962) develops a series of multidimensional information theoretic measures which may have useful applications in the organizational environment areas.

3. Litwak distinguishes between uniform and non-uniform technology (Litwak, 1961). Harvey (1968) discusses technology in terms of variability and product changes. Hage and Aiken (1969) measure the degree to which tasks are routine. Mohr (1971) discusses technology in terms of uniformity, complexity, and analyzability. Pugh, et al. (1968) define "rigidity of task operations" through a factor analysis of a large number of task variables.

4. Some interesting analogies can be developed from the research on individual human information processing. The research generally shows an inverted U-shaped relationship between information input load and output efficiency, as well as a U-shaped preference for uncertainty (see Schroder, Streufert, and Driver, 1967).

5. The following support this relationship between environmental uncertainty and communication network complexity: Dill (1958), Simpson and Gulley (1962), Woodward (1965), Lawrence and Lorsch (1967), Conrath (1967), Harvey (1968), Pugh, et al. (1968), Hage and Aiken (1969), Mohr (1971), and Aldrich (1972), Pfeffer (1973), Negandhi and Reimann (1973), and Duncan (1973).

6. The Bank as well as the Retirement Community network was defined on the basis of weekly or more frequent communication. For the Korean data, only dichotomous linked/not linked data were available. Full parameter settings for each of the runs are available from the author upon request.

7. The analysis has previously appeared in Danowski (1974).

8. A more extensive analysis of these data, of which the current analysis is a subset, appeared in Danowski (1975b).

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